MZCPA-ordered structural report

11 December 1996

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Site Development Committee
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RE: Site Visit 20 November 1996
Mount Zion Old School Baptist Church, US Rte. 50, Aldie Vicinity, Loudoun Cty, VA.
Ortega Consulting Project No. 96-22A

SITE VISIT REPORT

Richard Ortega, P.E., R.A., accompanied by Mr. Ben Lawrence and Mr. Ned Douglas, representing the Mount Zion Church Preservation Association, conducted a site visit on 20 November 1996. The site visit was requested by the Board of Directors of the Association in response to recent engineering observations that the west wall of the building was in danger of collapse. The purpose of the site visit was to conduct a visual condition survey of the existing building and adjacent property with particular emphasis on the severe masonry distress in the west wall. The purpose of this site visit report is to document the existing conditions, and provide recommendations that will be used to apply for restoration funds.

Prior to the site visit, Ms. Pamela Stephenson provided portions of the following previous reports for review: "Report to the Owners: April 17, 1994 . . . ," by Christopher Owens and "Mount Zion Old School Primitive Baptist Church," by John Carlton Grier, dated Spring 1992. The former document also contained the 1984 structural assessment prepared by Rev. Brown Morton, and a 1994 memorandum and cost estimates prepared by C. Richard Bierce, A.I.A.

The survey was conducted over a single four-hour period. We removed no fabric, nor did we do any sampling or testing of materials. Visual observations were conducted using available light augmented by hand-held flashlights; examination of suspicious areas was augmented by probing with hand tools such as scratch awls. The exterior, as well as the uppermost areas of the interior, which were not accessible to us, were surveyed using telephoto lenses. The following report describes our observations and review of existing building documents, including preliminary conclusions, and recommendations.

DESCRIPTION

The Mount Zion Church is situated on a relatively flat site, approximately 150' south of US Route 50, the John S. Mosby Highway. Immediately to the west of the building is a cemetery enclosed by a masonry wall approximately 10 feet from the west wall of the church. A board fence defines the other three sides of the church yard.

The building is a two-story, gable roofed, brick masonry building with stone foundations. It is a simple rectangular structure, approximately 46' by 36' in plan, with gable walls at the east and west, and side walls divided into three bays by pairs of stacked windows and doors. The two principal entrances are in the east gable wall and secondary entrances, giving direct access to the balcony, are in the east bays of the north and south sides. In the interior a "U"-shaped balcony runs along the north, east, and south sides of the sanctuary and there is a raised dais on the west gable wall, which also has two stacked pairs of windows flanking the dais. Although we did not go into the attic, views afforded through holes in the board ceiling and photographs in the previous reports indicate that the roof is supported on timber trusses that bear on the north and south walls; ceiling joists span between the trusses with end bays bearing on the gable walls; roof rafters bear on the side walls and probably receive intermediate support from purlins spanning between trusses.

OBSERVATIONS

The site visit began with a visual survey of the exterior building, followed by a survey of the interior, and finished with a return to the exterior where additional observations and measurements were recorded. The following summarizes those observations:

West wall

- The central portion of the west gable wall between the exterior jambs of the windows and extending from grade to above the second-floor windows, has both severely bowed and subsided. At the limits of this distress the wall exhibits vertical cracks and lateral displacement of the masonry at the jambs of the windows.

- Two pairs of "S"-straps are visible on the west gable in the spandrel panels between the

stacked windows. Each pair of straps consists of one small strap just below a larger strap; the small straps appear to coincide with the ends of the balcony framing and probably anchor the beams supporting the balcony; the larger straps are connected to iron chains that run the length of the building to another set of large "S"-straps at the east gable and tie the two gable walls together. The wall distress and displacement are particularly severe at the straps, which essentially mark the extreme limits of the wall distortion.

- Above the second floor level, on the face of the wall, about 12" from the south corner, there is a length of steel channel section. A steel cable, spanning the length of the building just above the balcony pews, connects the channel section with an anchor on the face of the east gable.

- Several bricks are displaced at the rake of the gable where perhaps a roof purlin bears on the wall.

- Distortion of the interior face of the wall, cracks in the interior plaster, as well as earlier repairs to the plaster conform to the type and direction of distress evident on the exterior face of the wall.

North Wall

- The north wall exhibits distress almost exclusively at the west end starting at the west window openings where the brick exhibits vertical and diagonal cracks as well as lateral displacement to the west.

- The base of the wall exhibits green organic stains and brown dirt stains caused by splash from rainwater flowing off the roof.

- Two terracotta pipe sections through the stone foundation wall, one about six feet from each corner of the building, appear to be an alteration effected to improve air circulation in the crawl space.

South Wall

- The south wall exhibits the same general pattern of distress as the north wall with significant distress around the west windows.

- A crack about 16" from the west corner extends vertically upward from grade and exhibits lateral displacement toward the west.

- The jack arch above the lower window in the middle bay has dropped and displaced outward approximately ¾".

- The base of the wall exhibits the same staining, and has the same terracotta pipe inserts as described above.

East Wall

- Like the west gable, the east gable has two pairs of "S"-straps in the spandrels of the outer bays of the wall. Unlike the west gable, on each side the larger strap is not aligned above the larger smaller, but is offset ±30" nearer to the corner of the building than the smaller strap. From the interior it appears that each smaller strap again aligns with the end of the beam at the front edge of each side balcony; the chain to which the larger straps are attached does not run parallel to the side walls, which is why the pairs of straps do not align the same way at each gable.

- At, or immediately next to, each of the large straps the brick masonry exhibits vertical cracks and is displaced inward. This distress extends the full height of each affected spandrel from the top of the door openings to the bottoms of the window openings above.

Roof

- The standing seam metal roof appears to have been either painted with black paint or coated with a black roofing tar. Nevertheless, it is evident that the treatment is no longer effective as discoloration and rust is evident.

- Damage and staining of the ceiling and adjacent areas of the side walls indicate failure of the roofing.

- The roof has no gutters or leaders, and projects only a few inches beyond the top of each side wall which is articulated with a shallow corbeled brick cornice.

Site

- Two large deciduous trees flank the east gable approximately six to twelve feet off the northeast and south east corners of the building, respectively. Two stumps remain of trees similarly located off the west corners of the building.

- There is an evident drip line at the base of the side walls where rainwater has eroded the topsoil. The overall topography of the site slopes toward the Little River to the west as does the grade in the immediate vicinity of the church. The grade along the west wall is mounded upward in the middle of the wall and drops of toward the corners, especially the southwest corner. Thus, the rainwater appears to drain toward the west end of the building and, thence, toward the northwest and southwest, although the sponginess of the soil suggests that the ground around the building absorbs much of the water.

- The soil at the base of the west gable wall is very soft. A small diameter steel rod probe easily penetrated 18" into the soil. In an effort to determine the depth of the foundations we probed at several locations along the wall. The building appears to be founded 12" to 18" below existing grade. Coincident with the north limit of the wall subsidence the probe hit a subgrade obstruction that precluded more than a few inches of soil penetration.

Windows

- There are stone shims above the window frames in the side walls and a filler course of cut brick above the jack arches on the west wall.

Interior

- A strong musty odor upon entering the building suggests active rot processes within the building. Staining and damage to the ceilings and walls as noted above supports that observation.

- The floor along the east wall has subsided and is excessively springy when walked upon.

CONCLUSIONS

It is evident that the west wall of the Mt Zion Baptist Church is in progressive failure. The observations made herein are consistent with the finding of "severe structural deterioration" as noted in Brown Morton's 1984 report. Because Mr. Morton indicates that the structural deterioration "is not immediately apparent to the casual observer, . . . ," one must conclude that the present structural condition is substantially worse than it was in 1984; I also doubt that the building, in its current condition, could have survived the twelve years between our site visit and Mr. Morton's.

A masonry wall in the state of deterioration of the west wall of the church is subject to sudden failure -- also called catastrophic failure. Brick is an excellent building material, and brick masonry construction is an excellent structural system, but they have limitations which are a function of the mechanical properties of brick and mortar. In particular, brick masonry is brittle and cannot resist tensile stresses. As long as a wall is plumb, is of sufficient thickness to resist lateral loads, and is of sufficient thickness to resist buckling, tensile forces do not occur. If, however, a wall should bow, for whatever reason, tensile forces will begin to increase in the outer edges of the bowed masonry. If the bowing cannot be stopped, the eccentricity of the loads caused by the bowing itself, will act to increase the bow in the wall, thereby increasing the tensile stress. Unless stabilized, this condition is progressive and ultimately will result in structural collapse. This is the situation that exists with the west gable wall of the church.

Most of the masonry distress evident in the adjacent side walls and in the opposite gable are secondary effects of the west gable wall movement. The bowing and westward drift of the west gable wall has rotated and laterally displaced the adjacent corners of the walls causing the side walls to distort and crack.

The efforts to stabilize the west gable by tying it to the east gable wall with the iron chains and steel cable did not address the underlying cause of the west wall distress and only transferred the problem to the east gable which, as is evident, was not strong enough. Indeed, this intervention appears to have only bought some time, but at the expense of the east gable wall.

Assuming the wall was not defective in its original construction, some action, event, or change in the existing conditions must have initiated the wall movement. Whatever caused the movement needs to be eliminated as part of any effort to stabilize the wall. As noted in Mr. Morton's report, the foundations at the west end of the building have subsided, which has caused distress and

distortion of the walls above, but we can only guess as to the cause of the subsidence. The building appears to be founded about 12" to 18" below existing grade -- this may be too shallow and the foundations may have been moved by frost heave action of the earth. Preliminary probes of the earth along the west wall found very soft soil at the base of the most distressed part of the west gable. This soil may have been disturbed by excavation, or roots of the adjacent trees, or compromised by water saturation from inadequate site drainage. We also found what we think may be shallow rock adjacent to the distressed wall section, which suggests inconsistent bearing conditions for the foundations. We are not familiar with the geology of the site, but there are soil types, and rock formations which, can degrade, shift, or subside, especially in contact with water or with changes in moisture content.

It is likely that it will be necessary to underpin most, or all of the west gable wall as recommended by Mr. Morton. The problem may be attributable to the shallowness of the foundations, but I suspect something occurred that changed the bearing capacity of the soil. To verify the causes and the existing conditions as well as to determine the depth and extent of the necessary underpinning will require a geotechnical investigation of the subsurface conditions in the vicinity of the building.

The building also suffers other distress that, while not as dramatic as the west gable wall, must also be addressed. The jack arches over several windows are displaced and failing. The metal roofing is corroded and leaking, which has caused damage to interior finishes and, most assuredly, elements of the roof structure. It is also likely that the floor framing has been damaged by either rot, or insects, or both.

RECOMMENDATIONS

The first priority needs to be to protect the public and to temporarily stabilize the wall in place. As the wall potentially could fail without any further warning, it would not be prudent to allow the public near it. Thus, access should be denied to the area between the west gable and the cemetery wall; and, at least until shoring is installed, the interior of the building should be closed to the general public.

If the west gable should fail, it would likely be in the form of a total collapse of the area between the exterior jams of the window openings, and not a generalized collapse of the building. But as the ceiling joists, balcony beams, and perhaps roof purlins, frame into the wall, one cannot ignore the possibility of the wall pulling down other elements of the building.

It has not yet been determined whether the Preservation Association, and the relevant reviewing agencies will want to preserve the wall *in situ*, as is, or will allow it to be rebuilt. Therefore, we recommend the following:

- Install raking shores to brace the wall as shown in the attached illustration. The wall should be sandwiched between timber grillages installed on both faces of the wall, using counter wedge shims to insure uniform contact and utilizing the window openings to tie the grillages together. Then the raking shores can be installed against the exterior grillage and anchored into the ground at the base of the cemetery wall.

- Install supports under the ends of the balcony beams where they bear on the west gable.

- Install shoring to support the ceiling joists and purlins that may bear on the gable wall.

- Disconnect, or loosen, the chains and cable that tie the two gable walls together.

As the winter season is the most likely time of year for conditions that would precipitate a masonry failure, it is recommended that the temporary shoring be installed as soon as possible.

Once these measures are effected, the following investigations and studies need to be done to determine the appropriate permanent repair and produce the construction documents:

- An historic structure report that identifies and dates the existing historic fabric, establishes a period of interpretation, and determines the appropriate historic appearance.

- A condition assessment, including structural condition, of all the historic fabric, not just the masonry walls and foundations. This would also involve surveying the roof framing, the balconies, and the floor framing.

- Geotechnical investigations to identify the mechanical properties of the existing bearing stratum and underlying geology.

- It may also be necessary to produce HABS quality documentation, either measured drawings, or large format photographs, or both, of the existing conditions before proceeding with the structural and masonry repairs.

- As the permanent stabilization of the wall will require extensive excavation around the building, it is likely that at least a Phase I Archeological Survey of the site around the building will be required.

Once the historic and existing condition documentation is complete you can proceed to determine the type and extent of intervention that is appropriate, then have the necessary construction documents produced to solicit bids, if necessary, and proceed with the repairs.

You will note that the observations, conclusions, and recommendations in this report generally agree with the observations and recommendations provided to the Mt. Zion Church Preservation Association by Mr. Morton, Mr. Christopher Owen, and Mr. Bierce. I am not familiar with the prevailing wages in the Aldie vicinity, so I cannot evaluate the cost estimates provided in those reports, except to note that:

- compared to comparable work in southeast Pennsylvania the estimates appear low; and

- we generally estimate the cost of underpinning this type of wall at ±$1,000.00 per foot of underpinning, so extensive underpinning of the building could use up much of the $160,000.00 estimated by Mr. Owen to stabilize the building.

It was a pleasure meeting you, Mr. Lawrence, and Mr. Douglas; and I appreciate the assistance you provided me. If you have any questions regarding this report, or if I can be of further assistance, please call me. I also would be pleased to provide whatever design assistance you may need to stabilize and safeguard the Mt. Zion Church.

Sincerely,

Richard I. Ortega, P.E., R.A.

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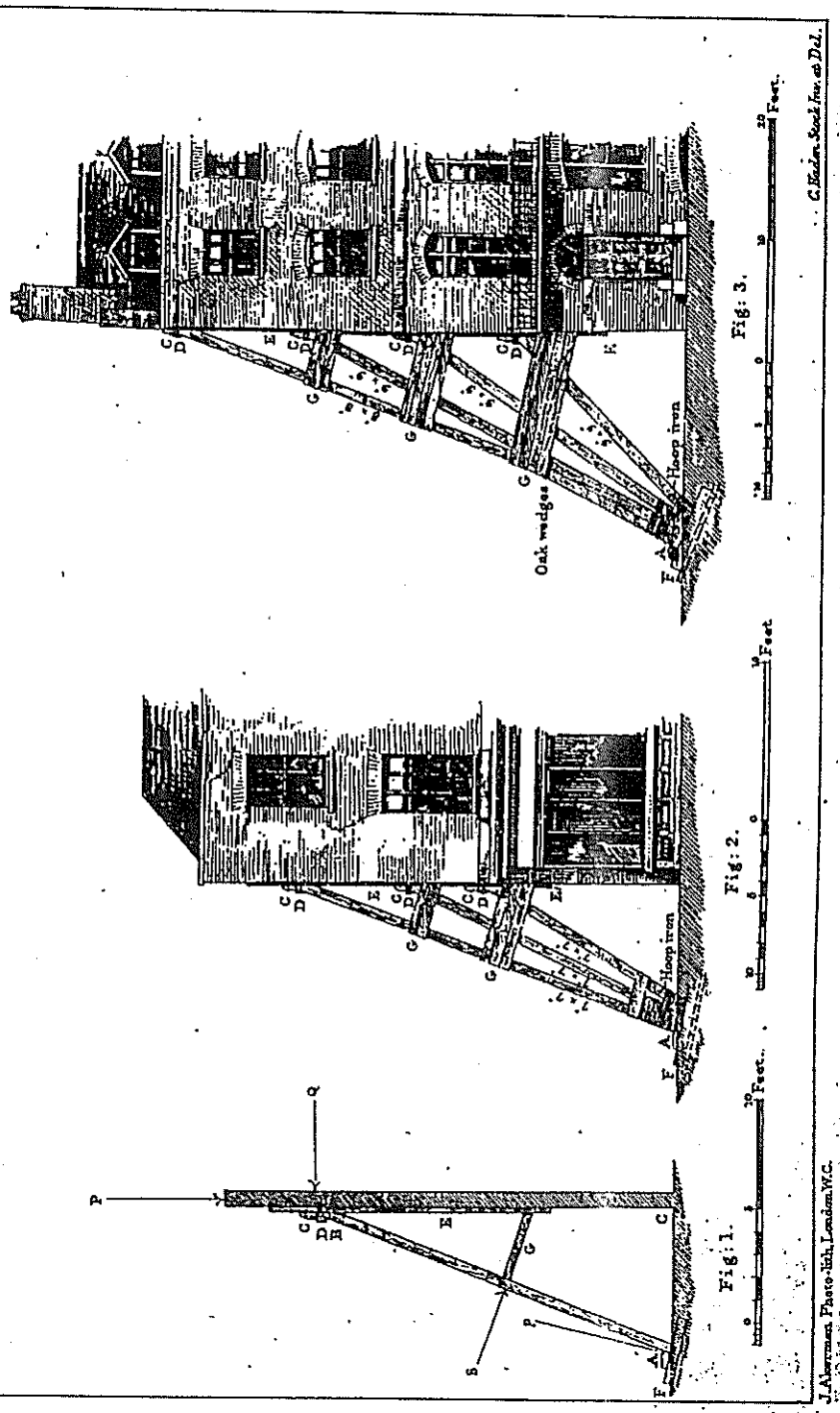
PLATE, 1.



CHAPTER II.

ON RAKING SHORES.

We shall describe in this chapter only the ordinary use of raking shores, reserving the different varieties of this method to be considered by themselves in another chapter.

In Plate II, Fig. 1, there is depicted an example of the raking shore in its most simple form, i. e. with only one principal strut. Let us suppose it to be supporting a brick-wall, 9 inches thick and 20 feet high from the ground, A C; then A B is the principal strut, called a shore; E is a deal, called the wall-piece, 9 inches wide and 3 inches thick, and long enough to take the foot of the secondary strut G. In this wall-piece, about 2 feet from one end, a rectangular hole is cut and a small piece of wood D, called a needle, or by some workmen a tossle, or joggle, is inserted, projecting about 4½ inches on either side of the deal. A half header is taken out of the wall near the top and the wall-piece placed in position, the needle fitting into the hole thus prepared. The other end of the needle, projecting beyond the face of the wall-piece, serves as an abutment to the head of the shore at B. For additional security a wedge-shaped piece of wood, C, called a cleat, is nailed on to the wall-piece just above the needle, and prevents it from being forced out of its place by the upward pressure of the shore AB. F is a balk of timber, called the footing block, or sole-piece, let into the ground, or if the ground be soft, laid upon a small platform of timber. A cleat is nailed upon the upper side of the sole-piece at A, to prevent the foot of the shore from slipping. All these parts in connection with the shore will be taken more in detail further on in this chapter; at present let it suffice only to name them and describe their functions.

Now, the object of this shore is to prevent the wall from being turned over by the thrust caused by a house leaning against it. In considering the resistance to be offered to this thrust, though it may but seldom be the case, yet we must always be prepared for it at its greatest magnitude, and that will be when it is great enough to upset the wall. The direction of this thrust will of course be at right angles to the wall, and it will act at a point near the top, i. e. where the head of the shore presses against the wall, as shown by the line Q in the figure. Now, the most convenient way to